DOCUMENT RESUME

ED 160 398 **SE 024 949**

AUTHOR	Kahn, M. S.; Hoffman, W. M.
TITLE	Structural Pest Control.
INSTITUTION	District of Columbia Dept. of Environmental Services, Washington, D.C.; District of Columbia Univ., Washington, D.C. Cooperative Extension Services.
PUB DATE	77
NOTE	66p.; For related documents, see SE 024 946-948; Not available in hard copy due to marginal legibility of original document
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	Agricultural Chemical Occupations; Health; *Herbicides; *Insecticides; *Pesticides; *Rodenticides; Safety; Science Education; *Weeds

ABSTRACT

This manual is designed for those who seek certification as pesticide applicators for industrial, institutional, structural, and health-related pest control. It is divided into six sections covering general pest control, wood-destroying organisms, bird control, fumigation, rodent control, and industrial weed control. The manual gives information for identifying and controlling common pests and emphasizes using pesticides safely. (BB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

pesticide applicator training manual

ED160398

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

STRUCTURAL PEST CONTROL

University of the District of Columbia
Cooperative Extension Service
1351 Nicholson Street, N. W.
Washington, D. C. 20011

1977

SE 024 949

2

The Cooperative Extension Service of the District of Columbia offers educational programs, assistance and materials to all people without regard to race, color or national origin.

The University of the District of Columbia and the U. S. Department of Agriculture cooperating. Distributed in furtherance of the purposes provided for by the Acts of Congress of May 8 and June 30, 1914.

Disclaimer Statement

Use of trade names in this manual does not imply endorsement of the products named nor criticism of similar ones not mentioned.

STRUCTURAL PEST CONTROL

M. S. Khan
W. M. Hoffman

Cooperative Extension Service
University of the District of Columbia
Washington, D. C.
1976

PREFACE

You must meet certain general and specific Federal and District of Columbia standards before you can use certain pesticides. You have been provided with a training manual that contains the information to help you meet the general standards. The emphasis of these standards are on the safe and effective use of pesticides.

This manual contains the basic information to help you meet the specific standards for applicators engaged in industrial, institutional, structural and health related pest control. It is not intended to furnish you with all the knowledge you need to be competent in your pest control activities.

The manual is divided into six sections corresponding to the sub-categories established to meet the certification requirements of the District of Columbia:

- General Pest Control,
- Wood-destroying Organisms,
- Bird Control,
- Fumigation,
- Rodent Control and
- Industrial Weed Control.

It will give you information about:

- recognizing common pests,
- pest control and pesticides and
- using pesticides safely.

Additional information can be obtained from the Plant Pathology and Entomology Division, Cooperative Extension Service of the District of Columbia, 1351 Nicholson Street, NW, Washington, DC, 20011.

ACKNOWLEDGMENTS

We wish to thank Dr. F. E. (Gene) Wood and other entomologists of the University of Maryland, Mr. Harold G. Russell, Jr. of Maryland Department of Agriculture, Mr. W. Childress of the Environmental Services and Dr. L. C. Gibbs of the United States Department of Agriculture.

We greatly appreciate the services of Mr. W. B. Easley and Miss J. Peace of the Cooperative Extension Service.

TABLE OF CONTENTS

Acknowledgments	i
Preface	ii
Introduction	1
Using Pesticides Safely	1
General Pest Control	3
Insects - General	3
Insects - Parasites of Man	7
Occasional Invaders	14
Stored Products Pests	22
Fabric Pests	25
Vertebrate Pests	26
Wood - Destroying Organisms	28
Termites	28
Powder-Post Beetles	33
Bird Control	36
Species Recognition	37
Bird Control Procedures	40
Fumigation	44
Preparation	46
Application	47
After Application	48
Rodent Control	50
Industrial Weed Control	56

INTRODUCTION

Proper identification of pests and a knowledge of pest development and behavior are keys to effective pest control. After you have identified the pests, you must decide how to control them. Removal of food, water, and habitat (place in which to live) is an important part of effective pest control, but should be combined with appropriate mechanical and chemical control methods. If you decide to use a pesticide, select a product that has label directions for the intended use. Various formulations can be used on a wide variety of jobs in many different types of equipment. Each formulation has its own characteristics that make it the best to use in a given situation. For example:

- for a space spray, you might use an insecticide in oil;
- for long residual activity in a dry situation, a dust;
- for a residual spray, either an oil solution or water emulsion;
- for a surface application of a residual where appearance is not too important, a wettable powder spray;
- for use around open flames and heat, an emulsion;
- for use around electrical installations, an oil solution;
- for use on or around linoleum, rubber, asphalt floor tiles, and some synthetic fibers, a water-base insecticide.

USING PESTICIDES SAFELY

Do not release pesticides into soil, air or water except where you intend to do so as a safe and approved part of your work. Pesticides put in the wrong place, or on the wrong plant, or where the wrong animal can contact or consume them are pollutants and may cause serious harm.

through which they may enter the building. Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls, equipment legs and bases, conduits, motor housings, junction or switch boxes.

Be sure to read the label to see whether the insecticide can be used in food handling establishments. If so, be sure to use only the treatment authorized.

GENERAL PEST CONTROL

This sub-category includes commercial applicators engaged in preventing, repelling, or controlling insects, fungi, or other pests within or adjacent to structures of any kind or where people may assemble or congregate and not including work in other sub-categories.

INSECTS - GENERAL

ANTS

Ants have a narrow waist between the thorax and abdomen; the antennae are elbowed. The reproductives have four wings of unequal length. Colors vary from yellow, tan, brown, reddish-brown to black. The stages in the life cycle of an ant are:

- egg,
- larva,
- pupa and
- adult.

Carpenter Ants: These ants are among the most conspicuous of our ants, being large and able to bite easily. They are of importance because of

the damage they do to structures. They can be 1/2 inch in length, vary in color from brown, black to red and can be winged or wingless. They construct their nests in the soft moist wood of hollow trees, logs or posts, boards or tree stumps. Inside buildings they nest in moist or decayed wood, porch columns, roof, window sills or any wood in contact with the soil. Carpenter ants do not eat wood but excavate galleries to rear their young. Coarse sawdust is an indication of their presence. They feed on honey dew from aphids and pollen, other insects, animal remains and food from the home. During the summer they come from outside into the home seeking food and water.

The common pest ants are the odorous house ant, harvester ants, thief ants, and field ants. Most build their nests in the soil. Those that invade buildings usually nest near foundation walls, in lawns or under concrete slabs.

Control both carpenter ants and other indoor- or outdoor-nesting ants by direct treatment of the nests with sprays, dust or granular insecticides directed at the nest and surrounding area. Baits may be used effectively in areas away from the nesting areas.

If you cannot locate the nest site, apply pesticides where the ants gain entry or hide along foundation walls; at doorways, window sills, or baseboards; behind built-in cabinets and furniture; or beneath refrigerators or other heavy appliances.

BEES AND WASPS

Both are nuisances and can be dangerous to man because of the female's ability to sting. These insects have similar life cycles:

- egg,
- larva,
- pupa and
- adult.

BEES

Bees such as honey, bumble and carpenter are pests around buildings.

Honey bees have brown fuzz on the head and thorax and are less than 1/2 inch long. They build nests in walls, chimneys and attics. Their combs may dissolve and honey will seep through the walls causing physical damage as well as objectionable staining. Other insects such as, wax moths and carpet beetles can exist on tne honey and cause damage.

Bumble bees have yellow hair on top of the abdomen. They build their nests in the ground, in straw, or even in buildings.

Carpenter bees are large (1 inch long) with a yellow thorax. They are like bumble bees in appearance but their abdomen is usually bare of all hair. They bore holes into exposed wood then make a 90° turn and follow the wood grain about 12 inches where their eggs are deposited.

Control:

Apply sprays or aerosols directly on the nests. When treating nests, wear appropriate clothing to protect against stings. Remove dead

bees, combs, and honey to prevent invasion by other insects. Swarms or colonies can be trapped and removed. Adult carpenter bees can be killed in flight or in tunnels. Caulk up holes in the evening after bees return to the nests after putting an insecticide in the hole. Note: Many people develop allergic or hypersensitive reaction to stings.

WASPS

Wasps, such as hornets, yellow jackets, paper wasps, mud daubers and cicada killers attack and destroy harmful insects around the home and garden. For example, hornets and yellow jackets kill house flies, blow flies and caterpillars while paper wasps kill corn earworms, army worms and other garden pests. However, wasps can attack people especially when these insects feel threatened.

SOCIAL WASPS

Hornets are large (1- 1 1/2 inch long), black with white markings.

Paper Wasps (Polistes) are elongated with slender abdomens, reddish-brown to brown. They are 1/2 - 3/4 inch long.

Yellow Jackets are black to yellow, smaller than hornets and less slender than paper wasps. They are usually not more than 1 1/2 inch long.

SOLITARY WASPS

Cicada killers are black and yellow, about 1 1/2 inch long.

Mud daubers are usually black with yellow markings.

Hornets and paper wasps build their nests above ground in trees, shrubs and under eaves while mud daubers restrict their nesting to eaves, porches and behind shutters. Yellow jackets build their nests in the ground, but the former occasionally builds above ground in wall voids, for example. Hornets and yellow jackets build oval paper-like nests while Polistes build honey comb sphere-like ones. Mud daubers construct nests of clay or mud while cicada killers dig holes in sloping ground and pile soil at the openings.

In the fall, hornets, yellow jackets and paper wasps leave their nests and die. Only the queen hibernates to continue the species. Mud daubers and cicada killers overwinter in their nests as larvae.

Control:

Spray nests at sunset or late evening when the insects are in the nest and less active. Direct sprays or aerosols at nests or the opening of nests. Keep away from the area once the nests are disturbed. It is wise to wear clothing to protect against stings when treating nests. Note: Many people develop allergic or hypersensitive reaction to stings.

COCKROACHES

The stages in the life cycle of the cockroach are:

- egg, enclosed in a capsule which contacts other eggs,
- several stages of nymphs, which look like adults but are smaller and wingless and
- the adult.

Generally cockroaches are flattened in appearance, brownish or dark and can move quickly. They are brought into homes and buildings with new and used furniture, boxes or other containers from food stores and elsewhere. They travel from one apartment to another along water pipes, cracks in the walls, and wall voids. Some species may enter structures from outdoors or come in through sewer lines.

The German roach is 5/8 inch long, brown with two black stripes running lengthwise on the pronotum (between the head and the wings). This roach has a short life cycle, so populations build up quickly where there is adequate food, warmth and protection especially in kitchens, bathrooms and basements.

The brown-banded roach is about 3/8 to 1/2 inch long, light tan in color and has two light-colored horizontal bands, one at the base and the other about midway back on the wings. This roach can be found in all warm places in the house (clock motors, appliances, luggage, furniture, etc.), so it is difficult to control. Their moisture needs are less and that explains why they can be found in rooms other than the kitchen or bathroom.

The American roach is 1 1/2 to 2 inches long and is reddish-brown in color. It is the largest of the roaches and likes warm and moist places, such as, commercial buildings, warehouses, apartments, sewers, basements and steam heated tunnels.

The Oriental roach is 1 to 1 1/4 inches long, shiny black or very dark brown in color. The females are wingless and the wings of the males cover the front half of the abdomen. This roach thrives in damp basements, moist areas as floor drains and gutter splashers. They live outside in garbage or under rocks in summer and move indoors in fall.

The wood roach lives under the bark of fallen trees or logs. The male is about 1 inch long, dark brown with a pale stripe on the outer margins of the wings. Females are slightly less than 1 inch long and have short wings. They are good fliers and are attracted to lights. Homes in wooded areas are often invaded by both sexes mating seasons. They can also be carried into homes on firewood.

Control:

In some areas of the country, there are other cockroach pests. Some of these are very similar in appearance to those described above but differ in their habits. As a result, proper identification is essential to control. Contact local experts for information on other species that may be important. The removal of food and water sources and destruction of breeding places is essential in obtaining satisfactory cockroach control.

In kitchens and living areas, apply insecticides as crack and crevice sprays or spot treatments to places where the insects hide. Label directions of residual-type insecticides permit only crack and crevice treatment to be used in commercial food handling areas. Common

"hide-outs" are behind and beneath built-in shelves and cabinets, in and beneath stoves and refrigerators, under sinks, and behind baseboards.

In basements, cockroaches hide beneath trash, in cupboards and washing machines, and in cracks and crevices in concrete, brick, or block walls. Sprays are usually preferred to dusts because they are easier to apply and the residue is not as visible. Dusts, however, can sometimes be placed into areas difficult to reach with sprays.

Use ULV (ultra low volume) and aerosol applications of contact sprays and flushing agents to supplement residual sprays and dusts. Use them alone where the label prohibits use of residuals. Insecticidal baits are useful in nearly all areas of infestation.

INSECTS - PARASITES OF MAN

Many insects feed directly upon man and other warm-blooded animals. In addition to their blood sucking activities, many are able to carry disease-causing organisms from one animal to another or to man.

BEDBUGS

The stages in the life cycle of a bedbug are:

- the egg, glued inside cracks and crevices in bedding,
- nymphs and
- the adult.

Bedbugs are oval-round, flattened, wide, reddish-brown and between 1/4 - 3/8 inch long. When bloated with blood (food), the body elongates

and swells and color change from brown to dull red. Several species can be found on humans, bats, birds, etc. They can be carried into home from theatres, hotels, public transportation and even the laundry.

They feed at night and hide by daylight in cracks, crevices, around the folds of mattresses, bed springs or in suitcases, behind pictures, furniture and so forth. If present in great numbers, an offensive smell is emitted.

Control:

Do not spray surfaces that will come in direct contact with the body. Spray the slats, springs and frames of beds. Spray mattresses and allow to dry out completely. Wash all bedding. Continue spraying cracks, crevices, openings and all places the bugs are liable to be hiding. Repeated treatment may be necessary.

FLEAS

Fleas are small insects without wings. The stages in the life cycle of a flea are:

- the egg,
- larva,
- pupa and
- the adult.

The adult flea is small, very dark, wingless and jumps. The larva is tiny, white, slender, wormlike. The pupa stage is small, oval and

white and may be hard to see due to collection of dust, hair, and debris on the cocoon. Larvae and pupae are most often found on pets, their bedding and sleeping areas and nearby cracks and crevices.

Fleas may become a problem when dogs, cats or other furry animals are permitted to enter houses and other buildings. Fleas attack humans as well and can be a serious problem if not checked.

Flea infestations in homes are usually noticed after a host animal (usually a cat or dog) has been removed. Adult fleas that develop from eggs laid earlier begin to bite people since the normal host is gone. Eggs may hatch over several months.

Control:

Treat for fleas in structures by using surface and crack and crevice sprays. Control them on animals by using dips, sprays, dusts or flea collars. The pest control specialist can treat the premises; however, the pet should only be treated by the owner or a veterinarian.

MOSQUITO

The stages in the life cycle of a mosquito are:

- the egg, which may be laid on water or in areas which later will be flooded, depending on the species,
- larva, found only in water,
- pupa, also found only in water and
- the adult.

Effective control requires community-wide efforts. Elimination of all mosquito breeding habitat is essential. Control mosquitoes in smaller areas for a limited time by using sprays, aerosols, or fogs.

TICKS

The tick is not an insect; it is more closely related to spiders. The stages in the life cycle of a tick are:

- egg,
- six-legged larva,
- nymph (or nymphs) with eight legs and
- the adult.

A number of ticks are parasites of man and other animals. The brown dog tick is a very serious pest not only to dogs, but is also a carrier of important diseases of man. Several animals can carry this tick. It is abundant in areas where the humidity is high and there is grass or underbrush where dogs or rodents run. It is capable of living indoors.

Adults are prevalent in spring to early summer and attack man, dog and other domestic animals. They are flattened, brown to blue gray, very tough-skinned with eight large legs. The male has a hard-white mark all over the back while in the female this shield or scutum reaches only 1/2 the length of the body.

Ticks can drop off the host and hide in cracks, window frames and furniture. Eggs may hatch over a five-month period.

Control:

Control is difficult since hiding places are [illegible]ied. [illegible] sprays or dusts as spot treatment in cracks, [illegible]ping areas [illegible] all suspected hiding sites. Repeat treatment at [illegible]ntervals. The owner or veterinarian can treat animals with the [illegible]d powders or dips. Widespread treatment of pesticides outside [illegible]ly be used in areas where incidence of ticks is known to be high [illegible] there is a danger of Rocky Mountain Spotted fever.

OCCASIONAL INVADERS

The term "occasional invaders" includes those pe[illegible] may occur in buildings at some stage of their life cycle, but wh[illegible]ot usually complete the entire life cycle within the building.

BOOKLICE (PSOCIDS)

Booklice are small (1/20 - 1/10 inch), yellowish, [illegible] insects with long slender antennae. They are found indoors and [illegible] do not harm people. They are found in damp places in structur[illegible] round food and books. They feed on fungi, starches, and mold[illegible]ow on cereal grains, book glue, sugars and other such materia[illegible] can be serious pests for the manufacturers of food products and [illegible]ers.

Control booklice by removing books and papers from [illegible]storage areas. Dehumidify the area; discard infested materials, [illegible]ources and practise sanitation. Directed sprays and aerosols [illegible]ctive on heavy infestations.

CENTIPEDES

Centipedes are many-legged, nuisance pests which are often considered by laymen to be insects. They have many body segments with one pair of long legs on each segment. They have long antennae, legs and tail appendages. They have one pair of legs on each segment and are larger than millipedes.

Only the house centipede lives indoors. They do not damage food supplies or household furnishings, since they eat insects, spiders, etc. They are beneficial but most people consider them pests and want them controlled.

CLOVER MITES

These are annoying household pests. They are very small (smaller than a pinhead), reddish-brown with eight legs. The front pair is the longest.

Where there is a lush growth of grass near buildings, this insect builds up and may become a nuisance indoors. They can be seen around windows and later will enter the structure. They cause little damage to humans or furnishings but leave a stain when crushed. They feed on grass, clover and other plants. The population increases in fall when they move inside seeking protection, food and water.

Clover mites are difficult to control. Methods that keep the mites from getting indoors give the best result. These methods include

establishing a plant-free strip 18 to 24 inches wide along foundation walls by using polyethylene material covered with gravel or stones. Direct pesticide sprays at the strip and walls or if a plant-free strip cannot be established, spray the foundation walls and the adjacent 10-foot strip of grass.

CRICKETS

Crickets are troublesome in houses located near grassy areas, dumps or refuse area. They enter through open doors, windows and cracks.

Field Crickets are 3/4 to 1 inch long; dark brown to black, live in grass, lawn and fence rows. They feed at night and are attracted to lights. The eggs over winter in the ground while adult move indoors.

House Crickets are smaller than a field cricket (1/4 - 3/4 inch), with 3 dark bands on the head and long thin antennae. The body is light, brownish-yellow. They feed on organic refuse and over winter as adults in buildings.

Both types can damage woolens, silks, cotton fabrics and several other organic materials. Both undergo incomplete metamorphosis-egg, nymphs and adult.

Control is difficult. Keep doors and other openings closed, caulk cracks and crevices. Spot treat with residual insecticides where the crickets are found. Sanitation outdoors is important. Spray dumps, garbage and grassy areas.

FLIES

Several species of flies are found in and around structures. The stages in the life cycle of a fly are:

- eggs, laid in moist places,
- larva (legless maggot),
- pupa and
- adult.

The most common filth flies are the house fly and the blow fly. The black blow fly is slightly larger than the house fly and is shiny black or bluish green. These flies are annoying and also may carry diseases of man.

Successful fly control must include a combination of sanitation, physical barriers (such as screens) and insecticides. Garbage, manure, and decaying plant and animal material must be removed. Control adults by spraying resting places. Baits can also be used. Impregnated resin strips can be used in some indoor situations.

Control of adult filth flies around livestock and poultry feeding operations requires the cooperation of the pest control specialist, the livestock producer, and the county sanitarian.

Drain and moth flies are very small flies, gray to black in color with one pair of wings. They are found near sinks and lavatories where they breed. The immature stage lives in the scum of shower drains or sink overflow, especially if hair collects. The larvae may be down in the same area. Adults normally will run and fly only short distances.

Control by cleaning scum and hair from clogged drains. Household disinfectants can be used.

Cluster flies are often a pest indoors, buzzing around and collecting in large numbers on light fixtures and at windows on warm, sunny days. They are slightly larger and more sluggish than the house fly. Adults seek protected places such as wall voids and attics to spend the winter. Screens are ineffective since the flies prefer to crawl in through small openings elsewhere.

Control is difficult. If possible, close all openings through which the flies can enter. Apply sprays and dusts to surfaces where flies are frequently seen and, where possible, wall voids and other confined spaces where the flies may be. In unventilated areas, impregnated resin strips are effective.

MILLIPEDES

They are gray or brown cylindrical worms, 1/2 - 1 1/2 inches long, with two pairs of short legs on each body segment. They curl up when disturbed. They are common on the forest floor, in compost piles, and in heavily mulched areas.

The stages in the life cycle of a millipede are:

- egg,
- nymph, smaller in size with fewer legs and
- adult.

When millipedes leave their natural habitats, they crawl over lawns and sidewalks and may invade buildings in large numbers. They cause no damage. Prevent invasion by removing leaves and compost around buildings and by sealing cracks in foundation walls and around doors, basement windows, crawl spaces, and vents.

Spraying a 10-foot wide strip around the foundation is helpful in control. Repeat applications may be necessary during periods of heavy migration.

SILVERFISH AND FIREBRATS

These are wingless insects about 1/2 inch long. They have three appendages at the end of their body. The stages in the life cycle of silverfish and firebrats are:

- the egg,
- young and
- adult, which continues to molt throughout its life span.

Both cause damage in homes by eating foods and other materials high in protein, sugar or starch. They eat cereals, moist wheat flour, any paper on which there is glue or paste, book-bindings, starch in clothing or rayon fabrics.

These insects are slender, wingless and covered with scales. The silverfish has a silver or pearl gray color while firebrats are mottled gray. Both have two long slender feelers at the head end and three long appendages at the tail end, each of which is as long as the body. These insects come out at night and hide during the day.

Both are common in homes. The silverfish lives in damp, cool places, such as basements while the firebrats choose hot dark places, such as fireplaces, furnaces, insulation and around hot water pipes. In apartments the insects follow pipelines from the basement to the floor in search of food. They are found in bookcases, closets, behind baseboards, windows and door frames.

Silverfish lay a few whitish, oval eggs which hatch in two to eight weeks, and this varies with the temperature. Firebrats lay about 50 soft, white and opague eggs which later turn yellowish and hatch in two weeks. Directed sprays applied to cracks and crevices that serve as hiding and resting places are most frequently used for control; dusts and baits may also be used.

SPRINGTAILS

They are minute insects, less than 1/5 inch long, often in enormous numbers on the surface and in the soil of woodlands, in decaying vegetation, and other damp places. They are wingless, with a forked appendage, at the tip of the abdomen, which is used for springing up in the air. These insects can be found in moist planters or in indoor plants.

Control by instituting measures which will lower the moisture condition. Sometimes, airing the room will be sufficient. Eliminate places of concealment. Treat outdoor breeding places and other habitats. Spray baseboards, door and window casings, bookcases, shelves, closets and other storage areas.

SOW BUGS AND PILL BUGS

The life cycle of both are:

- egg, retained in the female, then born alive,
- nymph, goes through 4 molts and
- adult.

They are light-gray or slate-colored, flat-bodied, segmented, 1/2 inch long with seven pairs of legs. Sow bugs have two short tail-like appendages while pill bugs do not have any. The sow bug can roll up into a small tight ball but the pill bug cannot.

They hide under dirt clods or bits of plant refuse and on the surface of benches. They feed at night on the roots and tender parts of plants. They live in moist places, under rocks, in cracks and foundations, under old boards and become a problem when they build up near openings of structures. They enter buildings and remain in basement areas.

Sanitation is important. Apply liquid residuals or dusts, indoors along baseboards, around windows and doors, and at both traps, as well as outdoors.

SPIDERS

Spiders are pests because of their webs. Most of them are harmless and are beneficial, feeding on insect pests.

A spider develops from an egg into an immature spider which may molt several times before becoming an adult.

The black widow and the brown recluse (fiddleback) can seriously injure humans. Neither spider bites unless provoked.

The female black widow is shiny black and distinctively marked with a red or yellow spot on the underside of the body, sometimes in the form of an "hour glass". This spider lives under rocks and boards and in or around buildings.

The brown recluse spider is tan to brown with a dark brown fiddle-shaped pattern on the front half of its back. It is usually found in buildings such as barns, sheds, garages, and houses that are dry, littered, undisturbed and contain insects that serve as food. Favorite hiding places seem to be the arms and legs of garments left hanging undisturbed. People are sometimes bitten while sleeping in beds or wearing clothes that have been unused for a length of time.

The yellow house spider enters houses in the fall, makes "cocoons" in places, such as doorframes, walls, ceiling joints, inside jets of unusued gas appliances.

Control insects that serve as food and remove webs by vacuuming. Direct pesticide sprays or dusts at hiding areas.

STORED PRODUCT PESTS

Most food products may be attacked by insects commonly referred to as "pantry pests". They eat or contaminate the products and make them

unfit for human consumption. They often leave the infested products and move about inside structures. To eliminate infestations, find and destroy infested material and treat the area wnere they are stored. Infested materials can be fumigated. Thorough cleaning is essential to prevent reinfestation.

Beetles and weevils are important pests of stored food. Usually both the larva and the adult will feed on foodstuffs.

The stages in the life cycle are similar:

- egg,
- larva,
- pupa and
- adult.

The confused and red flour beetles, the saw-toothed grain beetle, and the cigarette and drugstore beetles are small, reddish-brown insects usually less than 1/8 inch long. Their larvae are small and yellowish-white with brown heads. The adult often crawl over infested material and adjacent surfaces. Larvae and adults will be found in the infested material.

Cabinet beetle adults have various colored patches of scales on the back and are 1/8 inch long. Most of the damage is done by the larvae are fuzzy, light brown to black, and about 1/4 inch long. Adults feed mainly on flower pollen outdoors but may feed on stored food products.

The granary and rice weevils primarily attack stored whole grain. Adults are reddish-brown to black, about 1/8 inch long, and have pronounced snouts. Their larvae are small, white, legless grubs that feed and develop inside individual kernels of grain.

Moths cause damage by eating food, and contaminating food to the point where it cannot be eaten by humans.

The stages in the life cycle of the moth are:

- egg,
- larva,
- pupa and
- adult.

The Indian meal moth is a small moth with a wing-spread of about 1/2 inch. Its forewings have a coppery color on the outer two-thirds and whitish gray near the body. The pinkish-white caterpillars cover the materials on which they feed with loose webbing. The adults fly about near the site of the infestation. The larvae may also leave their food and crawl over adjacent surfaces. This is the most common moth which attacks stored food products.

The Angoumois grain moth is a tiny moth similar in size and color to the clothes moths. It may be seen flying about in daytime, whereas clothes moths avoid light. The caterpillars develop within whole kernels of grain.

FABRIC PESTS

Carpet beetles and clothes moths attack a variety of woolen products, furs, feathers, and hair. Infestations are common in boxes of old clothing, over-stuffed furniture, woolen carpets, and piano felt. These pests also destroy synthetic fabrics. The larva stage causes the damage. The presence of adults in an area may be the first sign of an infestation. Sometimes cast skins may be noticed.

The stages in the life cycle of beetles and moths are:

- egg,
- larva,
- pupa and
- adult.

Black carpet beetles are the most widespread and damaging of the fabric pests. The larvae are extremely active feeders. They prefer to feed on the dead bodies of other insects. For this reason, they are found in cereals and grain that are infested with stored product pests. The adults are shiny, black, oval, about 1/2 inch long. The larvae are cigar-shaped, tapering, reddish-brown to dark brown with a long brush of tail bristles. Furniture or common carpet beetles (Buffalo moth) are other beetle pests. The adults are round with specks of white, yellow and black. They are smaller than the black carpet beetle. The larvae are oval, hairy with short tails, yellow to brown in color. The larvae are omnivorous and feed on many types of plant and animal matter.

Webbing clothes moths are buff-colored with light reddish hairs on the head. The larva spins feeding tunnels of silk as it moves over its food sources.

Casemaking clothes moths are light brown with three dark spots on each wing. Larva encases itself in a small silken cell which it carries while feeding.

Prevention of entry is the key to good control of these pests. Proper cleaning and storage must be done. Dry cleaning and moth-proofing will resist moths. Carpets and rugs may have to be laundered or fumigated. Store fabrics in tight containers with moth crystals. Spray infested areas along edges of rugs, baseboards, furniture, closets, cracks with appropriate insecticide.

VERTEBRATE PESTS

This section will cover vertebrate pests, except rats and mice which are covered in the rodent control sub-category.

BATS

Bats are night flying mammals. They have leathery, membranous wings stretching from their front legs and toes along their body to the hind legs and tail. They feed upon insects. Some species roost in attics, hollow walls, chimneys, caves, and other similar places.

In addition to the general nuisance and odors associated with bat infestations, they harbor ectoparasites that may attack man. They carry and are subject to rabies.

Bat control can be accomplished by:

- bat-proofing buildings by closing openings 10mm or larger where bats roost. Carefully observe bats roosting areas to locate these openings or
- fumigation by using chemical repellents or pesticides.

MOLES

Moles burrow underground and rarely come above ground. Their burrows deface lawns and they may damage the roots of ornamental plants as they search for the earthworms they eat. Traps specifically designed for mole control may be useful in most situations.

RACCOONS

Raccoons may forage in trash or garbage containers or may enter buildings. They should be live-trapped and removed to a remote site.

SKUNKS

Skunks create nauseating odors, damage lawns, harbor ectoparasites, and are subject to rabies. They may enter buildings. Entrances should be closed when the skunk is outside or bait may be used to trap the animal outside the building for removal to a remote site.

SQUIRRELS

Squirrels of various species may enter buildings and be a nuisance or cause damage to the structure. They may bite when cornered. They carry ectoparasites. Squirrels can be controlled by using repellents or by using traps to remove them to remote areas and then closing the opening.

SNAKES

Snakes may find their way into and around buildings. Most of them are not poisonous but may frighten humans and may bite when disturbed. Removal of food and blocking hiding areas will usually force snakes out of an area. Keep snakes from getting inside by closing all points of entry.

WOOD DESTROYING ORGANISMS

This sub-category includes commercial applicators engaged in preventing, repelling, or controlling termites, powder post beetles, fungi and/or other wood destroying organisms in or on structures of any kind or pre-treating areas of the surrounding grounds where such structures are to be constructed.

TERMITES

The most damaging organisms that attack wood are termites. Treatment for termite prevention, control, and eradication is a major part of

structural pest control work. You must be especially competent in this area because your work is dedicated to the protection of man's property.

The stages in the life cycle of a termite are:

- egg,
- nymph and
- adult.

Termites are social insects having colonies in which there is a division of labor between different types of individuals. Nearly all species have reproductive and soldier castes, and many have a worker caste. If a worker caste is lacking, the nymphs handle the nest building and food gathering activities. These workers are responsible for the damage done to wooden structures. Within the reproductive caste are primary reproductives which have two pairs of long, whitish, translucent wings of equal size. They emerge from the colony during the warmer months of the year to disperse and form new colonies. Large numbers of the winged reproductives (emerging or swarming) may be the first indication of the presence of a termite colony.

They differ from the reproductive forms of ants, which have two pairs of transparent wings of different size. Termites have thick waist lines while ants have narrow, wasp-like waists. The termite's feelers look like a string of beads with no elbow while ants feelers consist of a long base segment which makes an elbow with the other bead-like segments.

SUBTERRANEAN TERMITES

This termite is so named because the colony extends below ground with the workers attacking wood above ground. The soil is the most common source of the moisture they need to survive. White, soft-bodied workers eat the soft grain of wood, leaving a thin shell outside and the harder portions in layers. They prefer wood in contact with soil but will construct "shelter tubes" from the soil through cracks in slabs, through expansion joints, inside masonry walls, along foundations or in cracks in foundations to get at the wood in buildings.

If "swarmer" (reproductive) termites have not been seen, the presence of a colony can be determined by probing wood near the foundation or by observing these "shelter tubes".

Termites occasionally become established without soil contact when a leaky roof or pipe provides moisture. Infestations may become established under concrete slabs, garage floors, patios, and filled dirt porches. Termites may then enter the building through structural wood or foundation walls adjacent to the slab. In houses built partly or completely on slabs, termites enter through expansion joints, cracks, and utility openings.

Breaking the connection between wood and soil is essential in termite control. This may be done with either a chemical or mechanical barrier. Soil on both sides of exposed foundation walls and soil surrounding supporting piers should be drenched down to the footing with

insecticide. Apply the insecticide by trenching and backfilling or a combination of trenching and rodding.

For outside basement walls (where the footing is deep), dig a V-shaped trench against the wall. It should be deep enough to ensure penetration to the footing. After trenching, use a perforated hollow rod to inject insecticide to the footing of the basement wall. When treating concrete block or brick foundation walls, drill them above the grade line and flood all voids with insecticide.

To treat slab-constructed buildings, saturate the soil beneath the slab. Inject insecticide either through holes drilled in the slab or by drilling and rodding horizontally under the slab. Either method must be done carefully to avoid heat ducts, pipes and vapor barriers located under the slab.

Treat filled porches by:

- drilling the slab from the top,
- drilling the porch foundation horizontally at each end next to the building and injecting the chemical by rodding, or
- making openings in the foundation wall, excavating the porch fill immediately under the slab and drenching the soil with insecticide.

DAMPWOOD TERMITES

They are not found in the District of Columbia.

Dampwood termites have a biology similar to that of subterranean, however, their colonies tend to be smaller. A major difference between

the two is that dampwoods seldom live in the soil. They nest in dampwood - and are usually associated with wood decay. They do not construct tubing runways. Small openings are made between the galleries and the wood surface. Six-sided fecal pellets are discarded from the galleries through these openings and serve as a means of identification.

Control consists primarily of correcting the moisture condition. The damaged wood often requires replacement. Pressure-treated wood should be used if the moisture condition will continue. If the wood is not to be replaced, the galleries should be drilled and flushed with an insecticide to eliminate the infestation.

DRYWOOD TERMITES

They are not found in the District of Columbia but have been found as far north as Cape Henry, Virginia.

Unlike subterraneans and dampwoods, drywood termites live and feed on sound, dry, seasoned wood. They have no soil connection and need no moisture source. The colonies are small and pellets are produced similar to those of dampwoods - but smaller.

Control consists of eliminating the colony. In minor infestations, this can be accomplished by removing the infested wood or by drilling it and injecting chemicals into the galleries. In many cases, however, fumigation of the structure is the only practical and effective control method. Treating attic spaces with a desiccant such as silica gel may reduce the chances of reinfestation.

POWDER-POST BEETLES

Beetles which, as larvae, feed in seasoned wood and produce finely divided frass, are known by the common name, "powder-post beetles". They are second to termites in their ability to destroy wood. The most common are the Lyctid and the Anobiid powder-post beetles. The adults are small (about 1/5 inch long) and usually reddish-brown to nearly black. The larvae are white, 1/8 to 1/3 inch long, and pupate in spring with adults emerging late spring to early summer. Eggs are laid in wood pores or in cracks and crevices, or occasionally in an old exit hole.

Small "shot hole" exit openings in the wooden surfaces are a sign of infestation. Slight jarring of the wood causes a fine powder to sift from their holes. When the wood is cut or broken, the interior reveals galleries filled with a finely-packed powder which is produced by the feeding of the larvae. Joists, subflooring, hardwood flooring, sills, plates, and interior trim are the parts of buildings most frequently attacked. Furniture and other wood products may also be damaged.

To prevent infestations or to control existing infestations, wet all surfaces thoroughly with insecticide. Furniture and other movable objects may be fumigated in special chambers.

LONG HORNED BEETLE

Long-horned beetles are large (1/2 to 3 inches long) and brightly colored. They have long, thin antennae which may be longer than the

body. Eggs are usually laid on unseasoned, rough-sawed timbers or logs. The larvae, called round-headed borers, feed in the wood. They bore large, oval holes as they move through wood.

The only species that requires control in structures is the old-house borer. The adult is about 3/4 inch long, grayish-brown to black and has two white patches on the wing covers. Its galleries have distinctive ripples on the interior surface. The old-house borer usually damages only pine sapwood.

For control, infested wood must be treated repeatedly with a liquid insecticide. Heavy timbers may be drilled to allow penetration into infested areas. Fumigation under a tarpaulin may sometimes be required.

ANTS, BEES AND WASPS

Carpenter ants frequently occupy nests of other organisms. They do not eat wood. They clear everything from the old galleries but do not usually enlarge it. Their cleaning activities create characteristic piles of different kinds of pellets, chops of wood and other debris. The entrance holes can be filled and resurfaced. If there are too many ants and all their locations can not be found, fumigation may be necessary.

Carpenter bees prefer soft wood. Redwood and unfinished wood is especially attractive.

Control flying adults with aerosols. Apply spray or dust in tunnels. When the bees return to their nests close the holes with putty or caulking compound.

Horntail wasps are frequently found in the wooden structures. The larvae bore into the trunks of living and dead trees and are "built" into a house. The adult leaves the wood, frequently boring through plaster or other penetrable surfaces. Emergence holes should be filled and resurfaced to match surrounding areas.

MARINE BORERS

Marine borers can be either mollusks or pileworms. They attack wood within brackish or salt water. These marine animals feed on plankton invade ships, pilings, wharfs, etc., simply for a place to live and from which to feed.

WOOD DECAY FUNGI

Severe wood decay occurs only in wood with a moisture content greater than 20 percent. Most wood-rotting fungi grow only on wood which is subject to wetting by rain, roof leaks, plumbing leaks, condensation, or contact with soil. Two species, however, can conduct water directly to wood. Fungi take their food from the wood as they grow and reduce the strength of wood, often making it brown and crumbly or white and stringy. Discoloration and powdery mold growth below the

surface of wood should not be confused with decay. The moisture content of wood may be measured with a moisture meter to accurately determine the need for control.

Fungicides will not stop wood decay once it has started, though they sometimes slow its progress. The key to complete control of wood decay is to eliminate the source of moisture. This may be done through:

- proper drainage,
- breaking contact between wood and soil,
- ventilation,
- the use of vapor barriers and
- other good construction practices.

Lumber, pressure-treated with preservative chemicals before use, may prevent attack by wood-destroying fungi.

BIRD CONTROL

This sub-category includes commercial applicators engaged in preventing, repelling, or controlling birds.

Of the thousands of bird species known to man, only a few are regarded as nuisance or pest birds. They are pigeons, sparrows and starlings and are not protected by the Federal migratory bird laws or regulations. Under the Fish and Wildlife Regulations for the District of Columbia Government (72 Stat. 814), 1959, all birds are protected. However, persons responsible for the care of property of the governments of the U. S. or the District may take such action as may be necessary to capture or destroy birds causing annoyance to the public, creating a

nuisance, or destroying or damaging property. Additionally, owners of private property can take humane actions as may be necessary to protect their own property or persons from destruction or damage by birds.

Pigeons, sparrows, and starlings -

- deface and destroy structures, plants, and other property,
- cause disturbances with their noises and droppings,
- contaminate food supplies and
- carry various diseases and ectoparasites.

SPECIES RECOGNITION

PIGEONS

Birds are 6-10 inches long, with varied colors. They display a fan shaped tail during take off or landing. Their heads bob when walking.

Pigeons mate for life. Breeding occurs year round. One or two eggs are laid which hatch after 18 days. The young leave the nest at 4-6 weeks. More eggs may be laid before the first young are gone.

Pigeons feed mainly on grain and other seeds and will take some green food and fruit. They habitually feed where food is available, such as public parks and zoos, vacant lots, warehouse areas and where people feed them. They need water and grit to assist in food digestion.

Pigeon nesting sites are usually located in protected places and may be in open buildings, on roofs and on building ledges. They also

have well-defined roosting and resting sites. Pigeons are creatures of habit and tend to return to the same places to feed, nest and roost.

SPARROWS

These are small birds (3-4 inches long) with a short bill. The male has a prominent black throat, white cheeks, dark gray crown, and a chestnut-colored nape. The female and young are dull gray above, light below, and have no distinctive markings. House sparrows prefer cavities for nesting. They will nest in vines and on buildings where the sites are protected. Nest building and egg laying begins in early spring. A clutch consists of four to eight speckled eggs that hatch in 13 or 14 days. They produce several broods a season and usually use the same nest. Generally, the birds are gregarious; they nest, roost and feed together in large flocks. They are seed eaters and supplement their diet with insects.

STARLINGS

The European starling is a stocky, short-tailed, black bird, slightly smaller than a robin (4-7 inches long). In summer, the adult starling has iridescent black plumage, a long, sharp, yellow bill and dark eyes. As winter approaches, small, buff-colored spots appear in the feathers, and the bill darkens. This coloration is maintained through mid-winter and the spots gradually fade away. Young starlings are plain brownish-gray with a dark bill, but assume the typical adult

winter plumage by fall. In flight, the greater tapered, pointed wings and short tail give the bird a triangular appearance. The flight is swift and straight--not undulating like that of native blackbirds.

Mated pairs of adult starlings begin nesting by mid-April in cavities such as tree hollows, woodpecker holes, bird houses, or building crevices. In cities, several pairs may nest as small colony in eaves, roofs and other structures. In general, starlings nest earlier than most native birds.

The nest is constructed of stiff, fibrous material lined with fine grass and soft material. The female lays three to eight pale greenish-blue eggs which hatch in about 12 days and the young remain in the nest for two to three weeks. Once the young can leave the nest, they join together in flocks of gradually increasing size. The adults, however, usually re-nest and produce another brood in late July and August. A third brood may be produced in early November.

Starlings eat almost anything and are highly adaptive in their food selection. These birds devour large numbers of insects, especially grubs, caterpillars and grasshoppers (they are especially efficient in probing soil for grubs). The nestlings are fed almost exclusively on insects. Starlings are also fond of fruits, especially grapes and cherries and will eat weed seeds and grain in season.

During the nesting season, starlings are aggressive birds. They will often take over a nesting cavity already occupied, evict the

occupants and build their own nest. After nesting, much of their individual aggressiveness abates with formation of large flocks. Starling flocks are highly cohesive. Apparently each bird yields part of its individual identity to the large flock identity, thus allowing the flock to bank, turn and twist without apparent leadership or signal.

The starling has a variety of whistles and rasping, squeaking calls, some of which are quite harsh. It is a clever mimic, however, and can imitate the robin, killdeer, bobwhite, cardinal and other birds.

BIRD CONTROL PROCEDURES

Sanitation is the first step in control. Food and water must be removed. Garbage should be handled in a manner that leaves none available for the birds. In an urban situation, this is almost impossible. Water is always available from fountains, or ponds and people take great joy in feeding birds.

Exclusion or building out to prevent roosting or nesting is very important. Openings in buildings, behind signs, under eaves can be screened with 3/4 inch mesh galvanized or rustproof wire. Roosting on ledges can be discouraged by covering them with wire netting or installing wood or metal sheathing at a sharp angle or building up with masonry. Glues, repellents, wires, or electrical devices can also be used but are expensive and not always effective. Other repellents, such as revolving

lights, noise makers, high frequency sound vibrations or tape recorded noise generally have only temporary effect and at best only move them to a new area.

Suppression or population reduction methods must be performed in conjunction with sanitation and exclusion. Methods include:

- nest removal,
- trapping and
- chemical control.

Nest removal every two weeks during the spring and summer may greatly reduce populations of sparrows and pigeons. A long pole with a hood can be used to tear down nests under eaves, rafters, and the like.

Trapping can be a very effective method of reducing pigeon and sparrow populations. Several different types of traps can be used. Funnel and "bob type" traps for pigeons; rat traps, sieve-type traps, funnel traps, nest box traps for the sparrow. They should be pre-baited for several days. Trapped birds should be removed daily. One or two birds can be left as decoys in the traps.

Chemical control with avicides or other pesticides may be the only means of effective control.

There are three pesticides registered for pigeon control. These are Ornitrol, Avitrol and Strychnine.

One of the newer pigeon control chemicals is Ornitrol. Ornitrol is a chemosterilant (sex sterilant). When applied at the right time, it inhibits egg laying and those few eggs that are laid are usually infertile. Ornitrol will not kill pigeons when applied according to label directions. Pigeon populations will remain static until death from other causes. Application of Ornitrol should be made in early spring and early fall before mating begins. For each 100 pigeons, scatter 7.5 lbs. of treated bait daily for 10 days. Ornitrol use is an excellent approach to management of pigeon populations where public objection to other toxicants is expected.

Avitrol is registered for pigeon control. Many birds species which consume Avitrol become distressed and utter distress and alarm calls which scare off other members of the flock. Consequently, while some mortality is to be expected, no mass reduction is necessary to provide dispersal of these birds. Affected pigeons do not appear to alarm other pigeons. Only the pigeons that consume Avitrol are controlled. If Avitrol is to be used, pre-bait with untreated whole corn for 7 days, then expose the Avitrol treated bait. The bait should be mixed one part treated to 10 - 29 parts untreated. The lower application rate (1 - 29) should be used only when other pigeon food is readily available. Be sure to check label directions. As Avitrol will kill pigeons, arrangements must be made to recover and dispose of dead birds. Bird mortality may not be a consideration in all cases, but when trying to disperse pigeon flocks in urban areas, governmental regulations and public reaction may make this an important factor.

Strychnine is also an effective toxicant registered for pigeon control. As with Avitrol, pre-bait for about one week with untreated whole corn, or until the pigeons are accustomed to the bait and the feeding site. If non-target birds are seen feeding on the untreated corn, do not apply the Strychnine. Use a different control technique. After the pigeons become accustomed to the untreated bait and the treatment site, sweep up the untreated bait and replace it with 0.6% Strychnine treated bait. After the desired level of control is obtained, remove the remaining treated bait. Strychnine can cause secondary poisoning in animals that feed on Strychnine poisoned pigeons, therefore it is essential that all dead birds be picked up and disposed of immediately.

There are two toxicants registered for sparrows: Avitrol and Strychnine.

The procedure for using Avitrol for the control of house sparrows is quite similar to that described for controlling pigeons. The area to be treated should be pre-baited, but instead of applying whole kernel corn, corn chops, sorghum, wheat or other mixed grains should be used. When the house sparrows are accustomed to the bait and feeding site, the untreated bait should be removed and Avitrol treated bait substituted. The process should be repeated until the desired population level is obtained. As with pigeons, house sparrows do not become alarmed by the distress caused in affected birds. The sparrows must consume the Avitrol to be controlled. Be sure to check the label directions and be sure to recover and dispose of all dead birds.

Strychnine bait (0.6%) is also effective in controlling house sparrows. The area to be treated should be pre-baited as described above, using the same type of bait. After house sparrows become accustomed to the bait and the feeding site, Strychnine treated bait should be substituted. Because of the danger of secondary poisoning, it is particularly important to recover and dispose of dead birds before any other animal has a chance to feed. Care must be also taken to protect non-target species.

There are currently no EPA registered avicides for use on starlings in urban locations.

FUMIGATION

This sub-category includes commercial applicators using fumigant within enclosed space for the destruction of a pest. Gaseous poisons used to kill insects are called fumigants. Their application is limited to plants or products in air-tight enclosures or those which can be enclosed in relatively gas tight tents or wrappings or to soil. Fumigants kill all insects as the gas enters the insect's body through the spiracles during respiration. Fumigants penetrate cracks, crevices, and the commodity being treated. They must reach the target pests as gases to be effective. As soon as a fumigant diffuses from the target area, reinfestation can occur.

Types of fumigation are:

- general fumigation (buildings and their contents),
- spot fumigation (machinery, facilities, bulk commodities),
- tarpaulin or chamber fumigation (packaged commodities and
- vehicle or in-transit fumigation (trucks and railway boxcars).

When choosing a fumigant, consider:

- toxicity to the target pest,
- volatility and ability to penetrate,
- corrosiveness, flammability and explosive potential,
- warning properties and detection methods,
- effect on seed germination and finished product quality,
- residue tolerances,
- availability,
- ease of application and
- cost.

Several factors can change the efficiency of fumigants. Consider these when selecting a formulation and dosage:

Temperature - The fumigant may not kill the pests if the product or space being fumigated is below 10°C (50°F) or above 46°C (115°F).

Moisture - As the moisture content of the commodity increases, it becomes more difficult for a fumigant to penetrate it. This also increases the potential for residues exceeding legal tolerances. Adequate moisture is required for the generation of some fumigants.

Pests - Susceptibility to fumigants depends on species, habitat, and stage of development. During some stages of their

life cycle, for example, many insects are protected by the product they infest.

Structure - Consider the condition of the structure, the type of construction, and the product it contains. A wooden structure, even when sealed well, will not retain fumigants as well as metal, plastic, masonry, or concrete. Fumigation in vacuum chambers allows increased efficiency.

PREPARATION

Understand fully the facility and commodity to be fumigated, including the:

- design of the structure, as well as adjacent and connecting structures both above and below ground,
- persons or animals expected to be at or near the area to be fumigated,
- the commodity, its history and condition (previous fumigation, temperature, moisture),
- availability of emergency shutoff stations for electricity, water and gas,
- location of nearest telephone, and numbers for fire or police departments, hospitals and physician.

You may need to notify local medical, fire and police authorities and other security personnel about:

- chemicals to be used,
- proposed date and time of use,
- type of gas masks required,
- fire hazard rating and
- name and phone number of person to contact in event of emergency.

Have alternate application and protective equipment and replacement parts available. Display warning signs near points of entry and provide for security of buildings. Have necessary first aid equipment available. Before treatment is started, develop plans to ventilate the area when the treatment period is over.

APPLICATION

Always assign two persons to each fumigation. Everyone involved in the fumigation should know first aid and other emergency procedures, including personal decontamination. Follow label directions exactly when applying a fumigant. Consider prevailing winds and other pertinent weather factors such as temperature and humidity. Apply fumigants from outside the exposed area wherever possible.

Inspect all valves, gauges, and in-plant piping before using a built-in fumigation system where fumigant source may be either inside or outside the area being treated. Return to the storage area all unused chemicals in clearly labeled, original containers. Dispose of empty containers correctly. Provide watchmen, when required. Entrances should be secured by guards or locks. Report to a physician indications of illness or physical discomfort, no matter how minor they seem. These symptoms and signs may include: dizziness, nausea, headaches, and lack of coordination. Do not consume alcohol for 24 hours before or after a fumigation.

AFTER APPLICATION

Before re-entry, use a suitable gas detector, as indicated on the label, to determine fumigant concentration. Do not depend on odors. Some fumigant gases are odorless. Wear correct respiratory equipment. Turn on all ventilating or aerating fans. Check for gas concentrations in areas that are expected to aerate slowly. Remove warning signs only after the gas concentration is within safe limits for human exposure. Remove and dispose of packaging and waste products of solid fumigants.

The most common fumigants are:

- Methyl Bromide: Colorless, odorless gas at room temperature. It is extremely toxic and will kill insects in all stages; egg, larva, pupa, and adult. It is effective on stored product insects and wood-destroying organisms. There are a number of items which should not be exposed to methyl bromide. Some are physically damaged while others react with the gas and cause long-lasting odor problems.

- Aluminum Phosphide: Solid, which is the presence of atmospheric moisture, breaks down and liberates a gas, hydrogen phosphide, (phosphine). The gas is colorless but smells like garlic. It is effective against all stages of insect life. At present, registrations are limited to grain and some food and animal feed products. It cannot be used on structural pests but it is easy to use and is very effective.

- Ethylene Oxide: Usually combined with carbon dioxide to reduce explosion hazard. These gases are both colorless; effective against insect eggs and other stages but do penetrate densely packed items. Used principally in commodities that could be damaged by other fumigants. Registered for control in furs, clothing, and foods. Food items have established tolerances is 50 ppm.

- Sulfuryl Fluoride: Colorless and odorless and a liquid when under pressure. It penetrates dry wood products very well and is registered for most wood-destroying insects (adult and larva stages), bedbugs and clothes moth. It is not registered for any food or drug items. In the presence of open flames or hot surfaces, it breaks down into a corrosive gas.

Fumigants are useful but have specific advantages and limitations. The advantages are:

- Toxic to many pests.
- Can be applied by various methods.
- Easy to apply without disturbing the commodity.
- Penetrate structures, commodities and equipment.
- Readily available and economical.

The disadvantages are:

- Toxic to humans.
- Require trained applicators.
- Target area or commodity must be enclosed.
- May injure seed germination.
- Temperature requirements may be hard to meet, especially in northern climates.

RODENT CONTROL

This sub-category includes commercial applicators engaged in preventing, repelling, or controlling rodents, specifically rats and mice. Rodents are the most troublesome and expensive of the vertebrate pests bothering man. They --

- contaminate and destroy food products,
- damage furniture, clothing, structures and other nonedible items,
- carry diseases and ectoparasites,
- bite children and adults,
- cause fires and
- co-exist with man.

The three most common rodents are:

- Norway, brown, or common rat,
- roof or black rat and
- house mouse.

Physical and other distinguishing characteristics of these groups are listed below:

Species	Norway rat	Roof rat	House mouse
Weight	10-17 oz.	8-12 oz.	1/2-3/4 oz.
Total length	13-18 in.	14-18 in.	6-7 1/2 in.
Head & Body	7-10 in. Blunt muzzle Heavy, thick body	7-8 in. Pointed muzzle Slender body	2-3 1/2 in. Pointed muzzle Small
Tail	6-8 in. Shorter than head and body Lighter on underside	7-10 in. Longer than head and body Uniform coloring	3-4 in. Equal or somewhat longer than head and body

Ears	Small, close-set	Large, prominent	Prominent for body size
Sexualy mature	2-3 months	2-3 months	1.5 months
Litters/years	4-7	4-6	Up to 8
No./litter	8-12	6-8	5
Pregnancy	22 days	22 days	19 days
Droppings	Blunt ends 4-6 in.	Spindle shape 3-4 in.	Rod shaped 1 1/2-2 in.

The Norway rat normally stays close to ground level and prefers to nest in burrows. The roof rat nests above the ground level in buildings. Rats have an average feeding range of 100 - 200 feet or more whereas mice may be restricted to 10 - 30 feet. While rats are shy of new objects in their environment, mice are more apt to investigate any changes. All of them have:

- well-developed sense of touch in the whiskers and guards hairs which they keep in contact with side surfaces as they run next to walls and other solid objects,
- not too well developed eyesight and probably color blind,
- keen sense of smell but not repelled by human odors,
- discriminating sense of taste prefer fresh to decayed food,
- keen hearing and
- excellent balance in jumping and climbing.

Rats and mice are mostly nocturnal though under certain conditions can be seen during the day. However, their presence can be readily detected by:

- droppings
- runways in vegetation, greasy smears indoors

- burrows (normally made by Norway rats but the others will also use burrows)
- gnawings in wood,
- tracks and
- odors.

Controlling rat populations, not individual rats is the key to a successful rodent control program. Examples of populations are the rats within a city block, those in a sewer, or those living in and around a food plant. At any given time each of these areas has as a certain capacity to support a certain number of rats. This number is related to the availability of food, water, habitat and living space. Long-lasting control is dependent on a program that eliminates one or more of these vital factors.

There are two basic methods of rodent control. The first, environmental management entails:

- Managing refuse by storing it in rodent-proof containers of sufficient size and removing these at frequent enough intervals for proper disposal so as not to furnish food, water and shelter for rodents;
- Storing rodent-usable materials and supplies 12-18 inches off the ground and away from walls or in rodent-proof containers;
- Sweeping floors regularly and promptly stopping all leaks to cut down on these sources of food and water;
- Eradicating nesting sites and access to buildings;
- Taking rodent-proofing designs into consideration when planning new structures or modifying old ones;
- Rodent-proofing doors, windows and other openings through which rodents might enter. Clearance, including holes around pipes and utilities should have less than 1/4 inch (1/2 inch in case of rats only);

- Using rat-resistant materials (26 gauge or heavier sheet metal, hardware, cloth or masonry products) near grade level and
- Removing or blocking dead spaces such as double walls or floors.

The second method of control is rodent extermination, is the elimination of the existing population and is only a supplement to environmental management. This can be accomplished by:

- trapping,
- poisoning and
- fumigation.

Trapping is preferred where chemicals are prohibited or where the rodents may die in inaccessible places and cause foul odors or be a source of fleas. Both rats and mice prefer to run next to walls or other surfaces. Detection can be aided by painting a six-inch, white strip around walls, sweeping up all old evidences of rodents and placing tracking powder (light sprinkling of dust, talc, flour, etc.) on the runways so tracks can be seen. Place traps and baits in these runways. Traps may be used with bait, or the trigger device may be expanded and used without bait. Place trigger end of the trap toward the wall. Rats approach new objects cautiously and may be "trap shy".

The mouse investigates any new object or change in its territory, so that changing placement of baits or traps will improve control. Each male house mouse establishes a territory which may not extend more than 10 feet from the nest. For this reason, baits and traps should be placed no more than 10 to 20 feet apart. To encourage mice to range farther to find food and water, disrupt their environment as often as is practical.

The use of poison baits is the most effective means of extermination. The two categories of rodenticides are:

- multiple-dose anticoagulants and
- single-dose poisons.

Baits have special characteristics, uses and hazards. Some are highly toxic to humans and pets. Mix, handle and apply them according to label directions. Keep baits away from people and desirable animals. Place them deep into burrows or use bait stations. Dispose of excess baits and dead animal carcasses frequently.

Mice will eagerly sample new food. Rats, however, usually approach new food with caution. If it tastes bad or makes them sick, they will not eat it again. This is "bait shyness". When using bait for control, use a bait that is fresh and identical to the food the rats are using. If you use a different bait base, pre-bait in the area for a few nights before using a toxic bait. Rats require water to drink. Mice may get water from the food they eat. If all water sources can be eliminated, liquid baits are very effective for rats but only moderately so for mice.

The anticoagulants, such as warfarin, Pival, Fumarin and diphacinone prevent the normal clotting of blood and cause the rodent to die by internal bleeding. They must be ingested for several consecutive days before they become effective. A marked reduction in bait consumption and rodent activity occurs about the third day. Bait shyness is not commonly associated with their use. Their use provides a definite

safety factor for a child or an animal that may eat a single portion of bait.

Single-dose poisons depend upon the eating of a lethal amount of poison at one meal or before the onset of poisoning symptoms. They must be mixed with acceptable foods to be effective. In places where children or other animals might be endangered, baits should be placed under cover.

The most common single-dose poisons are:

- Fortified Red Squill - a botanical poison with a natural emetic action. Its strong taste makes it unacceptable to roof rats or mice.

- ANTU - quick acting poison for Norway rats. Relatively safe for man but not pets. Rats will not accept repeated doses. Young rats have natural tolerance. ANTU is effective when used once every 6 or 12 months. Also available as a tracking powder.

- Zinc Phosphide - black, insoluble in water, metallic compound with a disagreeable odor which appears to attract rodents but is objectionable to man and pets.

- Sodium Fluoroacetate, 1080 - very poisonous and very fast acting (kills rats in 1-8 hours). It also has strong toxicity to man and animals (there are stringent restrictions on its use).

Fumigation for rodents is limited to out-of-door burrows treatment. The most common fumigant is calcium cyanide. It is applied with a special duster. Place the nozzle in the burrow and close the mouth of the burrow on completion of the dusting. Animals are killed and buried in one step. Do not use in a building or in burrows that could direct the gas into a building. The carasses of all rodents recovered from the poisoning, trapping, or gassing operations and all uneaten poison baits should be buried or burned. Always wear rubber gloves when handling dead animals.

After the use of rodenticides, it is important that regular routine inspections be made of the premise to assure sanitation practices are being followed, rodent-proofing structures are intact and re-invasion detected.

INDUSTRIAL WEED CONTROL

This sub-category includes commercial applicators engaged in preventing, repelling, or controlling weeds on commercial or industrial sites.

WEEDS

Weeds around structures may need control because:

- they create a fire hazard,
- they harbor insects or rodents and
- they shorten the life of metal fences and buildings.

Weed control can be done by:

- Non-selective vegetation control (bare-ground) - residual, broad-spectrum herbicides used to kill all plant growth and prevent new growth for a season or more. Used along fences and foundation borders, near waste disposal lines, or as a soil treatment before paving sidewalks, parking areas, loading docks, etc. Such a treatment reduces fire hazards, promotes security and safety and eliminates a harborage for rodents, birds and insects.

- Short-term vegetation control - herbicides are used at rates that give a good knockdown of existing vegetation and retard the re-growth. Used where bare ground is not necessary.

- Selective weeding - control of certain plants without permanent injury to desirable plants, such as, lawns, flower beds, tree or shrub plantings.

- Chemical trimming and pruning - use of contact herbicides to give narrow bands of controlled weeds around desirable plants or buildings. Often used to give a mowing strip around trees or under guard rails.

- Mechanical or cultural control - use of hoes, blades, fertilization, landscaping, competitive planting, or other nonchemical methods to control unwanted vegetation.

Herbicides can be applied as pre-emergence or post-emergence treatments.

A herbicide can affect plants by:

- killing the plant or plants parts that it contacts.
- killing when the herbicide is absorbed for foliage and transported throughout the plant, or
- killing when roots absorb the herbicide dissolved in soil moisture and translocated throughout the plant (may last a season or more in the soil but requires rain, irrigation, or mechanical incorporation-discing-for activation in the soil).

Factors affecting herbicide performance:

1. Type of weed - all herbicides are selective to some extent and will fail to kill some types of plants. Some herbicides will work

better on grasses and some will work better or broadleaf plants. Perennial weeds can often grow back from their extensive root systems and will require multiple treatments or special techniques and herbicides. Brush control may be particularly difficult but can be done in the following ways:

- Foliage absorbed - usually applied in the summer.
- Basal stem - applied to soil around stems or clumps in late winter or early summer.
- Stump treatment - application of herbicides to freshly cut stumps.
- Dormant cane treatment - applications of fuel oil during winter.

2. Type of soil - sand or other soil low in clay and organic matter will not absorb the herbicide as much, so lower amounts will give equivalent results. Leaching will be more of a problem. Soils high in clay or organic matter will absorb some of the herbicide. More herbicide and more rainfall is usually necessary for effective control.

3. Rainfall - too much rain soon after a contact herbicide is applied can nullify its effectiveness but the same amount of rain might facilitate the action of a root-absorbed herbicide. Rainfall may also wash herbicides away from the target plants injuring non-target plants and animals.

4. Growth stage of plant - foliage-absorbed herbicides will usually work only when the plant is growing actively. Pre-emergence

herbicides must be applied before the weeds have emerged or a contact herbicide will have to be added to kill those that have emerged. Where selective herbicides are used, it is important that the non-target plants be healthy.

5. Sunlight - some herbicides can be nullified if they remain on the soil surface too long and are degraded by the action of light.

Choose equipment for the type of herbicide treatment desired. The pump will usually be a high volume (10 gpm or more) but under low pressure (50 - 100 lbs psi). Nozzles will usually be selected to give uniform coverage with large droplets to minimize drift. Mechanical agitation in the tank is required if wettable powders will be used.

In the District of Columbia, a hand sprayer may suffice, especially if other plant materials are to remain.

REFERENCES

EPA Publication 1976 — Industrial, Institutional, Structural and Health Related Pest Control

Extension Publications and Bulletins — (a) Iowa State University, Ames, Iowa

(b) Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Fitzwater, William D. and Roy S. Cole 1976 — Commercial Pesticide Applicator Manual, College of Virgin Islands, CES

Metcalf, Flint and Metcalf 1962 — Destructive and Useful Insects, 4th Edition, McGraw Hill Book Company

USDA 1976 — Controlling Household Pests, Home and Garden Bulletin No. 76

Wood, F. E., 1975 — Household and Structural Pests, Department of Entomology, University of Maryland

Young, Eugene, 1975 — Training Manual For The Structural Pesticide Applicator, California State Polytechnic Univ., Pomona, California